Mohamed *et al.*
Ain-Shams Journal of Anesthesiology (2023) 15:10
https://doi.org/10.1186/s42077-023-00310-0

Ain-Shams Journal of Anesthesiology

ORIGINAL ARTICLE

Open Access

Comparison between ultrasound-guided transversus abdominis plane block and quadratus lumborum block for open nephrectomy surgeries

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Abstract

Background This prospective randomized study was performed on 80 patients, 21–60 years old, scheduled for open nephrectomy surgery. Patients were equally allocated to two groups: the transversus abdominis plane block (TAPB) group and the quadratus lumborum block (QLB) group. Both groups received 0.3 ml/kg of bupivacaine 0.25% on the side of the operation. Total postoperative pethidine consumption, time to rescue analgesia, postoperative visual analogue scale (VAS), and pethidine-related postoperative nausea and vomiting (PONV) were recorded.

Results Total postoperative pethidine consumption was significantly lower in the QLB group: 73.75 ± 23.99 mg versus 115.63 ± 31.87 mg in the TAPB group. Time to 1st rescue analgesia was significantly prolonged in the QLB group: 477.075 ± 49.2 min versus 430.825 ± 48 min in the TAPB group. The VAS was significantly lower in the QLB group, on arrival to the Post-Anesthesia Care Unit (PACU), and at 1, 4, 8, and 12 postoperative hours. At 16 and 24 postoperative hours, both groups showed nonsignificant differences in the VAS scores. In the QLB group, 20% of patients had PONV versus 35% of patients in the TAPB group with no significant difference.

Conclusions QLB efficiently reduced pain after open nephrectomy surgeries, in terms of quality and duration of pain control compared to TAPB.

Trial registration FMASU MD 90a/2021/2022. The trial was registered on the 23rd of May 2021, with Pan Africa Clinical Trials Registry (PACTR202110858627849) on 27 October 2021

Keywords Postoperative pain management, Quadratus lumborum block, Transversus abdominis plane block, Open nephrectomy surgery

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Background

One of the most disturbing complications following surgery is postoperative pain. Opioids, the common analgesic, have many adverse effects as follows: drowsiness, constipation, physical dependence, sedative adaptation, pruritus, respiratory depression, nausea, and vomiting (Woodhouse and Mather 1998). Various methods are used to manage postoperative pain and minimize the usage of narcotics (Ng et al. 2002). Benefits of adequate postoperative analgesia include early ambulation as well as reduction in postoperative pulmonary complications, risk of thromboembolic events, and cognitive dysfunction (McDonnell et al. 2007).

The TAPB was documented for management of postoperative abdominal pain in 1993 by Kuppuvelumani and his colleagues (Kuppuvelumani et al. 1993). The sensory nerves that pass along the anterolateral abdominal wall from T6 to L1 are blocked by TAPB (Almarakbi and Kaki 2014). Three approaches are described to perform ultrasound-guided (USG) TAPB: the subcostal approach, the lateral approach, and the posterior approach, which targets to deposit the local anesthetic in the posterior end of the three muscular layers between the internal oblique and the transversus abdominis muscle. The anterior and lateral cutaneous nerves are blocked in this area from T_9 to T_{12} dermatomes (Tsai et al. 2017). The posterior approach gives analgesia for nephrectomies and kidney transplants more effectively than other approaches (Mavarez and Ahmed 2021). In 2007, Blanco provided the first description of the QLB and its effective postoperative analgesia after abdominal surgeries. In the following years, four different techniques for the QLB were introduced: lateral, posterior, anterior (transmuscular), and intramuscular approaches. The anterior QLB block covers the area from T4 to T12–L1 dermatomes, blocking the anterior and lateral cutaneous nerves (Mavarez and Ahmed 2021).

The subcostal incision approach for simple nephrectomy provides adequate exposure and less postoperative pain nephrectomy (Rozen et al. 2008). Blunt dissection of the layer between the renal fascia and the psoas muscle is done. The peritoneum is dissected off the ventral portion of the renal fascia until the renal vein is identified (Chatterjee et al. 2004). According to the subcostal incision of nephrectomy, it is needed to cover the dermatome from T10 to L1, and these dermatomes is covered by both TAPB and QLB (Rozen et al. 2008).

This study aims to compare unilateral USG-QLB with unilateral USG-TAPB in patients planned for open nephrectomy surgeries under general anesthesia (GA), regarding the postoperative analgesic properties; the total postoperative pethidine consumption in the first 24 h; time to first rescue analgesia; postoperative VAS at rest on arrival to the PACU (0 h); after 1 h in the PACU; at , 8, 12, 16, and 24 postoperative hours; and the pethidine-related side effects.

Methods

Eighty adult patients, aged 21–60 years, American Society of Anesthesiologists (ASA) classes 1 and 2, planned for open nephrectomy surgeries with subcostal approach under general anesthesia were enrolled in the study. At the end of the surgery, blocks were carried out by the attending anesthesiologists.

Exclusion criteria included patient refusal, psychiatric illness, coagulopathy disorders or the use of antiplatelets or anticoagulants, thrombocytopenia, hepatic disease, chronic pain, infection at the site of injection, local anesthetics allergy, *BMI* < 15 kg/m^2, or > 30 kg/m^2 (Fig. 1).

Patients were divided into 40 patients in each group as follows:

- *Group TAPB (N = 40)*: Where each patient received a unilateral TAPB in addition to general anesthesia
- *Group QLB (N = 40)*: Where each patient received a unilateral QL block in addition to general anesthesia

Prior to surgery, each patient was asked for a detailed medical history and underwent a full physical examination. Investigations including coagulation profile, CBC (complete blood count), kidney and liver function tests, and electrocardiography (ECG) were done. The VAS to measure postoperative pain was described to the patients; a mark is written on a horizontal line of a predetermined length of 10 cm to depict a scale where 0 represents no pain and 10 represents the most excruciating pain (Aldrete 1995).

On arrival to the operating room, 5-lead ECG, pulse oximetry, and noninvasive blood pressure (NIBP) were applied. A wide-bore intravenous (IV) cannula was inserted, and IV Ringer's solution started. Twenty minutes before induction of GA, premedication with 0.02 mg/kg of midazolam IV was given. Induction of GA with fentanyl (2 μg/kg), propofol (2 mg/kg), and then atracurium (0.5 mg/kg) IV was done. Endotracheal intubation with mechanical ventilation was started. Maintenance of anesthesia was done with 1.2% isoflurane in mixture 50% oxygen in air, atracurium (0.1 mg/kg) was given every 30 min, and fentanyl infusion was started at the rate of 1 μg/kg/h (Yousef 2018).

At the end of the surgery and before extubation, patients were divided into 2 equal groups, to receive either unilateral USG-TAPB or unilateral USG-QLB on the side of operation under complete aseptic precautions using a 21-gauge 120-mm Locoplex Sono needle.

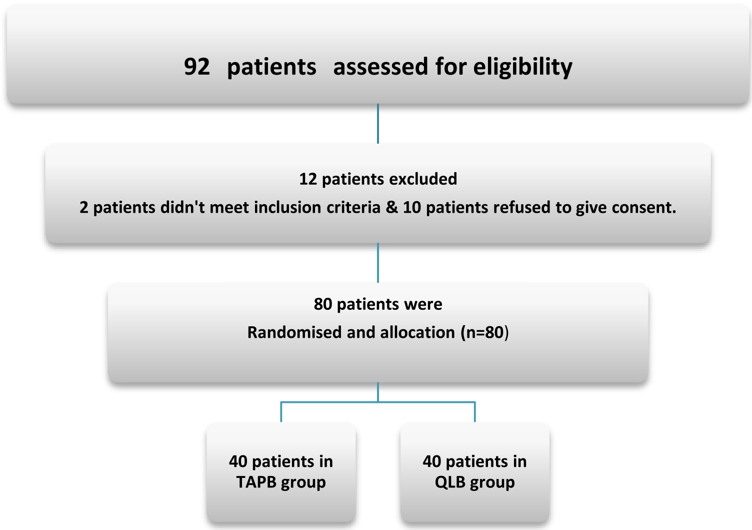

Fig. 1 Exclusion criteria

Group TAPB (N = 40): Patients received unilateral posterior TAPB. The posterior approach to the TAPB was used. Patients were positioned in the supine position. A linear high-frequency probe covered with a sterile sheath was located in the midaxillary line at the level of the triangle of Petit and moved posteriorly until the TAP was reached. The needle was inserted by an in-plane technique. The bupivacaine was deposited between internal oblique muscles and the transversus abdominis muscle at the posterior end limit of the TAP (Mavarez and Ahmed 2021; Yousef 2018). The correct site of injection was verified by injection of 3-ml normal saline showing hydro dissection between the two muscles, and 0.3 ml/kg of 0.25% bupivacaine was injected in this plane (maximum bupivacaine dose was calculated as 2 mg/kg) (Stav et al. 2016*)*.

Group QLB (N = 40): Patients received unilateral anterior QLB. The anterior approach to the QLB was used (QLB3). In this group, while the patient was still in the lateral position, the convex low-frequency curved probe was covered with a sterile wrap. The probe was vertically positioned above the iliac crest and moved posteriorly until the QL was visualized (Mavarez and Ahmed 2021; Yousef 2018). Bupivacaine was administered into the plane with the needle tip positioned between the psoas major and the QL muscles. The correct site of injection was verified by downward displacement of the psoas major and hydrodissection between the two muscles upon injection of 3-ml normal saline. After confirmation of correct needle position, 0.3 ml/kg of bupivacaine 0.25% was injected into this plane (maximum bupivacaine dose was calculated as 2 mg/kg) (Stav et al. 2016*)*.

After completion of the block, patients were extubated after reversal of the atracurium by neostigmine 0.05 mg/kg and atropine 0.02 ml/kg. Patients were transferred to the PACU for 1 h of observation and then discharged to the ward when reaching a Modified Alderete score of 9 and more (White and Song 1999). In the ward, IV infusion of 1-gm paracetamol was given regular every 8 h. Postoperative rescue analgesia was given for *VAS* > 3 as 25-mg pethidine IV, to be repeated twice to achieve VAS < 3 at the time of assessment and at any time of patient complaint of pain with a maximum dose of 200 mg/24 h (Accessed on 10/2/2021h https://reference.medscape.com/drug/demerol-meperidine-343315).

Primary outcome

Total postoperative pethidine consumption for the first 24 h in both groups

Secondary outcomes

- Mean blood pressure (MBP) recorded on arrival to the PACU (0 h), after 1 h in the PACU, and at 4, 8, 12, 16, and 24 postoperative hours in the ward
- Heart rate (HR) recorded on arrival to the PACU (0 h), after 1 h in the PACU, and at 4, 8, 12, 16 and 24 postoperative hours in the ward
- Pain assessment at rest by the VAS was started on arrival to the PACU (0 h), after 1 h in the PACU, and continued in the ward at 4, 8, 12, 16, and 24 postoperative hours.
- Time to first rescue analgesia needed once VAS score reached > 3
- Pethidine-related PONV

Statistical analysis

Sample size calculation was done according to the study done by Kumar et al. (2020) by community department Ain Shams University. Sample size of at least 30 patients per group achieves 80% power to reject the null hypothesis of zero effect size, when the population effect is 0.08 and the significance level (alpha) is 0.05 using a two-sided sample equal variance *t*-test.

The data were evaluated using SPSS version 22.0. The mean and standard deviation (SD) or the median and interquartile range (IQR) express numerical data. Frequency and percentage were used to express the qualitative data. The acceptable margin of error was set at 5%, while the confidence interval was set at 95%. Therefore, a *p*-value of 0.05 or higher was considered significant.

Results

Both groups were comparable regarding the demographic data (age, sex, ASA status, and BMI), with *p*-values 0.6, 0.64, 0.82, and 0.28, respectively (Table 1). The duration of surgery and the total anesthesia time were comparable between the two groups, with *p*-value 0.3 and 0.34, respectively (Table 2).

In the current study, the two groups were comparable according to the MBP at 0, 1, 4, 8, 12, 16, and 24 h, with *p*-values 0.85, 0.7, 0.97, 0.5, 0.9, 0.85, 0.54, and 0.57, respectively (Fig. 2).

In the current study, the two groups were comparable according to the HR at 0, 1, 4, 8, 12, 16, and 24 h, with *p*-values 0.73, 0.97, 0.94, 0.95, 0.93, 0.61, 0.31, and 0.23, respectively (Fig. 3).

Regarding the total amount of pethidine consumption in the first 24 h, it was found to be statistically significant higher in the TAPB group as compared to the QLB group (115.63 ± 31.87 mg versus 73.75 ± 23.99 mg, respectively), with *p*-value < 0.001. Time to 1st rescue analgesia was statistically significant prolonged in the QLB group as compared to the TAPB group (477.1 ± 49.2, 430.8 ± 48.1 min respectively), with *p*-value < 0.001 (Table 3). Regarding the postoperative VAS at rest, patients in the TAPB group had significantly higher median VAS scores compared to those in the QLB group from the time of arrival to the PACU and at 1, 4, 8, and 12 postoperative hours, with *p*-values < 0.001, < 0.001, 0.0002, < 0.001, and 0.0275, respectively. However, at 16 and 24 postoperative h, both groups showed similar VAS scores with no statistically significant differences (*p*-values = 0.49, 0.52, respectively) (Table 4).

In the current study, 14 patients (35%) in TAPB group express post operative nausea and vomiting versus 8 patients (20%) in QLB group with *p*-value 0.13 (Fig. 4).

Table 2 Difference between TAP group and QLB group regarding operative and anesthetic duration

	TAP group ($n = 40$)	QLB group ($n = 40$)	*p*-value
Duration of surgery(min) *mean ± SD*	99.6 ± 24.1	94.4 ± 22.2	0.3
Anesthesia time (min.) *mean ± SD*	113.9 ± 27.4	108.2 ± 25.3	0.34

Data expressed as mean ± SD, *t* student *t*-test, *TAP* transversus abdominis plane block, *QLB* quadratus lumborum plane block

Discussion

Regarding the VAS in the present study, the QLB patients revealed better VAS scores compared to the TAPB patients, from the time of arrival to PACU until 12 postoperative hrs. However, at 16 and 24 postoperative hours, both groups showed similar VAS scores with no statistically significant difference. This was reflected on the total amount of pethidine consumed during the first 24 h, which was significantly higher in the TAPB group as compared to the QLB group. This may be explained by the fact that the QLB covers

Table 1 Difference between TAP group and QLB group regarding demographic data

Demographic data	TAP group ($n = 40$)	QLB group ($n = 40$)	*p*-value
Age (years)*mean ± SD*	41.55 ± 7.05	40.78 ± 6.2	0.6
Sex			
Male	24 (60%)	26 (65%)	0.64
Female	16 (40%)	14 (35%)	
ASAnumber (%)			
I	18 (45%)	21 (52.5%)	0.82
II	22 (55%)	19 (47.5%)	
BMI (kg/m^2)*mean ± SD*	25.9 ± 2.7	25.2 ± 2.8	0.28

Data expressed as mean ± SD, proportion, *t* Student *t*-test, χ^2 chi-square test, *TAP* Transverses abdominis plane block, *QLB* Quadratus lumborum plane block, *ASA* American Society of Anesthesiologists, *BMI* Body mass index, *p*-value > 0.05 is considered non-significant

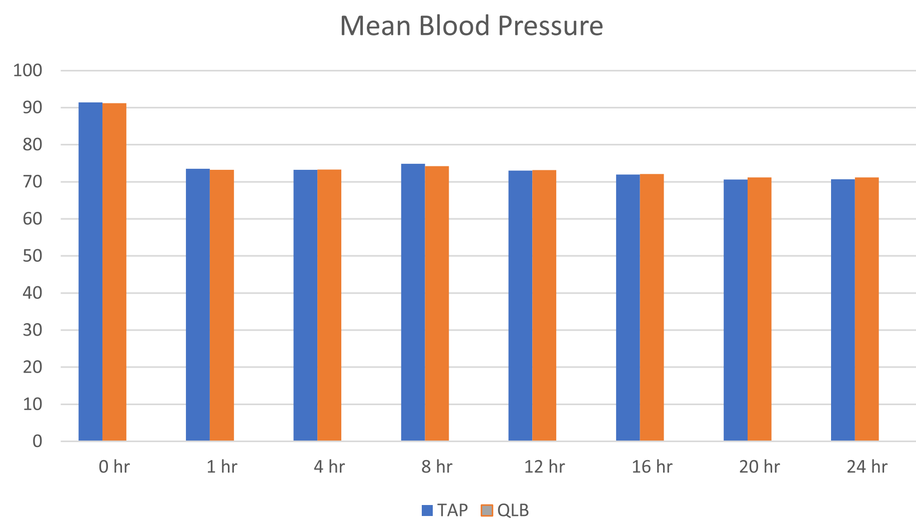

Fig. 2 Difference between TAP group and QLB group regarding MBP. *X*-axis for MBP and mmHg for the numbers written, *Y*-axis for time. Data expressed as mean ± SD or number and *p*-value. TAP, transverses abdominis plane block; *QLB*, quadratus lumborum plane block; *MBP*, mean blood pressure, *p*-value > 0.05 is considered non-significant

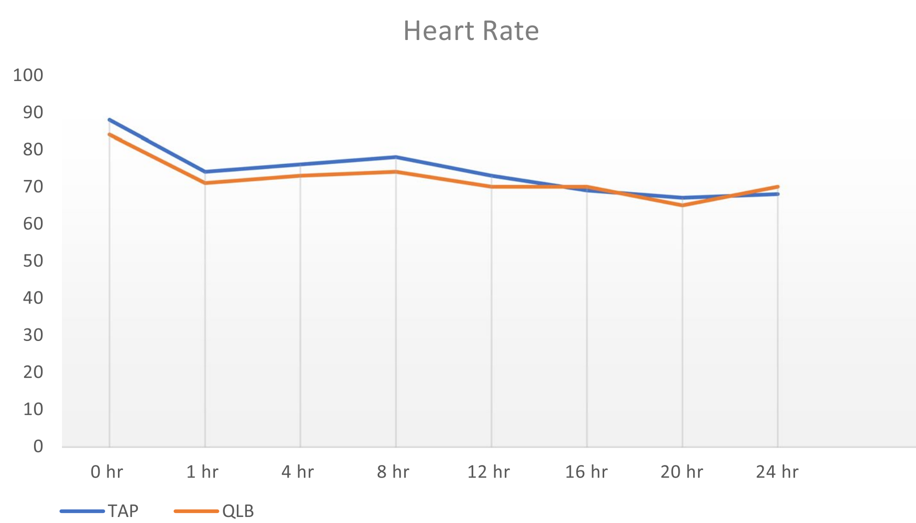

Fig. 3 Difference between TAP group and QLB group regarding HR. *X*-axis for HR and bpm for the numbers written, *Y*-axis for time. Data expressed as mean ± SD or number and *p*-value. TAP, transverses abdominis plane block; *QLB*, quadratus lumborum plane block; *HR*, heart rate, *p*-value > 0.05 is considered non-significant

more dermatomes than the TAPB, has better posterior and cephalad spread, and provides visceral as well as somatic analgesia due to the paravertebral spread (Mavarez and Ahmed 2021; Blanco et al. 2016). According to Blanco, the advantage of the QLB is the local anesthetic spread to the thoracic paravertebral area. This lengthens the duration of analgesia and increases the distribution of the local anesthetic. In aggrement with our study, a meta-analysis done by Xiancun and his colleagues (Xiancun et al. 2020) showed that the QLB analgesia was superior to that by the TAPB at 2, 4, 6, 12, and 24 h with less postoperative consumption of morphine during the first 24 h. Also, in agreement with our study, Blanco and his colleagues (Blanco et al. 2016) reported the superiority of the QLB compared to the TAPB for postoperative analgesia at 12, 24, and 48 h, with patients who received QLB requiring significantly less morphine than those who received TAPB. Also, in harmony with our results is the study done by Yousef (Yousef 2018) which reported lower VAS scores for postoperative pain at 0.5, 2, 4, 6, 12, and 24 postoperative hours, with bilateral QLB compared to bilateral

Table 3 Difference between TAP group and QLB group regarding total pethidine consumption in 24 h (mg) and time to first rescue analgesia (min)

	TAP group ($n = 40$)	QLB group ($n = 40$)	*p*-value
Total pethidine consumption in 24 h (mg)	115.63 ± 31.87	73.75 ± 23.99	**< 0.001**
Time to first rescue analgesia (min)	430.8 ± 48.1	477.1 ± 49.2	**< 0.001**

Data expressed as mean ± SD, *TAP* transverses abdominis plane block, *QLB* quadratus lumborum plane block, *p*-value < 0.001 was considered as highly significant

Table 4 Difference between TAP group and QLB group *postoperative pain score*

VAS	TAP group ($n = 40$) Median (IQR)	QLB group ($n = 40$) Median (IQR)	*p*-value
0 h	3 (2–3)	1 (1–2)	**< 0.0001**
1 h	3 (3–4)	2 (1–2)	**< 0.0001**
4 h	3 (2–4)	2 (2–3)	**0.0002**
8 h	3 (3–4)	2 (2–3)	**< 0.0001**
12 h	3 (2–3)	2 (2–3)	**0.027**
16 h	3 (2–3)	3 (2–3)	**0.49**
24 h	3 (2–3)	3 (2.5–3)	0.52

Data expressed as median and IQR, *Z* Mann-Whitney test, *TAP* transversus abdominis plane block, *QLB* quadratus lumborum plane block, *p*-value > 0.05 is considered non-significant; *p*-value < 0.001 was considered as highly significant

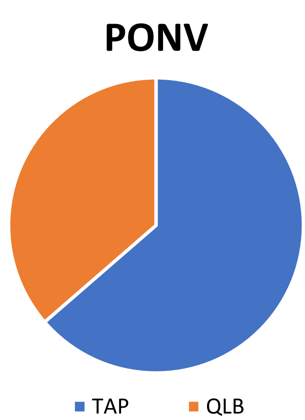

Fig. 4 Difference between TAP group and QLB group regarding complications. Data expressed as proportion, PONV, postoperative nausea and vomiting; TAP, transversus abdominis plane block; *QLB*, quadratus lumborum plane block, *p*-value > 0.05 is considered non-significant; *p*-value < 0.05 is considered significant

TAPB. Fewer patients in the QLB group required analgesia following surgery, and postoperative morphine consumption was lower. They concluded that QLB offered more efficient postoperative analgesia as compared to TAPB. Another study by Kumar and his co-workers (Kumar et al. 2018) found that postoperative analgesia during abdominal procedures was best managed by QL; it offers statistically significant better pain scores up to 16 postoperative hours than TAPB, with no significant difference in the pain scores at 24 postoperative hours, indicate fading of both blocks. Also, Naaz and his co-workers (Naaz et al. 2021) showed that QLB provided greater pain control than TAPB as evidenced by lower VAS scores at 15 min, 30 min, and 1, 2, 6, 12, and 24 postoperative hours, with longer duration of analgesia was observed in the QLB compared to the TAPB.

Regarding the total amount of rescue analgesia consumed in the first 24 h, the current study recorded significantly higher pethidine requirements in the TAPB group patients compared to the QLB group patients. In agreement with our study, Kolacz and his colleagues (Kolacz et al. 2020) compared the postoperative analgesia of QLB with TAPB in patients undergoing renal transplantation. According to their findings, patients who received QLB needed much less fentanyl in the first day following surgery than those who received TAP block. Contradictory to our results was the study done by Baytar and his colleagues (Baytar et al. 2019), who studied the effect of subcostal TAPB and QLB for postoperative pain relief and found that the dynamic and resting VAS and total analgesic consumption between both groups were without statistically significant difference. However, they reached the conclusion that because subcostal TAPB can be performed quickly and easily, it may be preferred to QLB. This discrepancy between our results and their results may be due to the difference in the type of TAPB used (subcostal approach) as compared to posterior TAPB in our study or possibly because a smaller amount of local anesthetic was used for the bilateral block.

Regarding time to first rescue analgesia, in our study, it was significantly prolonged in the QLB group compared to the TAPB group. In agreement with our study, Malla and his colleagues (Malla et al. 2021) found that the time to 1st rescue analgesia was delayed in the QLB than in TAP; this was reflected on significantly lower analgesic demands at 12, 24, and 48 postoperative hours. Similarly, Kumar and his colleagues (Kumar et al. 2018) found that the time required for 1st rescue analgesia was delayed with QLB as compared to TAPB.

Regarding the hemodynamic specifications observed in the present study, groups were comparable according to the MBP and HR. In harmony with our findings, Naaz and his co-workers (Naaz et al. 2021) and Malla and his colleagues (Malla et al. 2021) reported insignificant hemodynamic changes when comparing both groups.

In the current study, the clinical incidence of PONV was less in patients of the QLB than in patients of the TAPB but without statistical difference. In harmony with our results, Baytar and his colleagues (Baytar et al. 2019), and Xiancun and his colleagues (Xiancun et al. 2020), found that PONV was documented in the TAPB group and in the QLB group without any statistical difference between the two groups.

There were some limitations to our study; the use of patient-controlled analgesia (PCA) may have given more accurate results for the determination of cumulative postoperative opioid consumption than intermittent doses of rescue analgesia. Also, the VAS was not assessed on movement, and time to first ambulation was not assessed and compared in both groups.

Conclusions

The QLB was more efficient in delivering postoperative analgesia after open nephrectomy than the TAPB in terms of postoperative pain scores, total analgesic consumption, and time to first rescue analgesia requirement, with reduction in PONV.

Abbreviations

ASA	American Society of Anesthesiologist
BMI	Body mass index
CBC	Complete blood count
ECG	Electrocardiogram
ETCO2	End-tidal carbon dioxide
HR	Heart rate
IQR	Interquartile range
MAP	Mean arterial blood pressure
Kg	Kilogram
NIBP	Noninvasive blood pressure
PACU	Postanesthesia care unit
QLB	Quadratus lamborum block
IV	Intravenous
TAPB	Transversus abdominis plane block
USG	Ultrasound guided
SD	Standard deviation
VAS	Visual analogue score
Wt	Wight

Acknowledgements

Not applicable.

Authors' contributions

GA designed the study, revised literature, followed the patients, and critically reviewed the manuscript. MS designed the study, analyze the data, and wrote and critically revised the manuscript. GS and DK revised literature and followed the patients. AM collected the data, performed the analysis, and wrote the manuscript. The authors read and approved the final manuscript.

Funding

We did not receive any financial support.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due (Publishing the clinical data about any study conducted in our hospitals and approved by the institutional ethical committee is against the policy of the Faculty of medicine, Ain Shams university unless there is a reasonable request) but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by Research Ethics Committee at Faculty of Medicine, Ain Shams University, with approval number (FMASU MD 90a/2021/2022); the participants provide consent.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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Received: 27 October 2022 Accepted: 12 February 2023
Published online: 17 March 2023

References

Accessed on 10/2/2021h https://reference.medscape.com/drug/demerol-meperidine-343315

Aldrete JA (1995) The post-anesthesia recovery score revisited. J Clin Anesth 7(1):89–91

Almarakbi WA, Kaki AM (2014) Addition of dexmedetomidine to bupivacaine in transversus abdominis plane block potentiates postoperative pain relief among abdominal hysterectomy patients: a prospective randomized controlled trial. Saudi J Anaesth 8:161–166

Baytar Ç, Yılmaz C, Karasu D, Topal S. (2019) Comparison of ultrasound-guided subcostal transversus abdominis plane block and quadratus lumborum block in laparoscopic cholecystectomy: a prospective, randomized, controlled clinical study. Pain Res Manag. 2815301.https://doi.org/10.1155/2019/2815301

Blanco R, Ansari T, Riad W, Shetty N (2016) (2016) Quadratus lumborum block versus transversus abdominis plane block for postoperative pain after cesarean delivery: a randomized controlled trial. Reg Anesth Pain Med 41(6):757–762

Chatterjee S, Nam R, Fleshner N, Klotz L (2004) Permanent flank bulge is a consequence of flank incision for radical nephrectomy in one half of patients. Urol Oncol 22:36–39

Kolacz M, Mieszkowski M, Janiak M, Zagorski K et al (2020) Transversus abdominis plane block versus quadratus lumborum block type 2 for analgesia in renal transplantation: a randomised trial. Eur J Anaesthesiol 37(9):773–789

Kumar GD, Gnanasekar N, Kurhekar P, Prasad TK (2018) A comparative study of transversus abdominis plane block versus quadratus lumborum block for postoperative analgesia following lower abdominal surgeries: a prospective double-blinded study. Anesth Essays Res 12(4):919–923

Kuppuvelumani P, Jaradi H, Delilkan A (1993) Abdominal nerve blockade for postoperative analgesia after caesarean section. Asia Oceania J ObstetGynaecol 19(2):165–169

Malla MS, Ashraf S, Najib R, Hakeem A (2021) Ultrasound-guided quadratus lumborum block verses transversus abdominis plane block for post-operative analgesia in patients undergoing total abdominal hysterectomy: a prospective observational study. Asian J Med Sci 12(11):119–124

Mavarez AC, Ahmed AA (2021) Transabdominal plane block. StatPearls Publishing, In StatPearls

McDonnell JG, O'Donnell B, Curley G, Heffernan A et al (2007) The analgesic efficacy of transversus abdominis plane block after abdominal surgery: a prospective randomized controlled trial. AnesthAnalg 104:193–197

Naaz S, Kumar R, Ozair E, Sahay N et al (2021) Ultrasound guided quadratus lumborum block versus transversus abdominis plane block for postoperative analgesia in patients undergoing total abdominal hysterectomy. Turkish J Anaesthesiol Reanim 49(5):357–364

Ng A, Swami A, Smith G, Davidson AC et al (2002) The analgesic effects of intraperitoneal and incisional bupivacaine with epinephrine after total abdominal hysterectomy. AnesthAnalg 95:158–162
Rozen WM, Tran TM, Ashton MW, Barrington MJ et al (2008) Refining the course of the thoracolumbar nerves: a new understanding of the innervation of the anterior abdominal wall. Clin Anat 21:325–333
-Stav A, Reytman L, Stav MY, Troitsa A, et al. (2016) Transversus abdominis plane versus ilioinguinal and iliohypogastric nerve blocks for analgesia following open inguinal herniorrhaphy. Rambam Maimonides Med J. 7(3). doi:https://doi.org/10.5041/RMMJ.10248
Tsai HC, Yoshida T, Chuang TY, Yang SF, et al. (2017) Transversus abdominis plane block: an updated review of anatomy and techniques. Biomed Res Int. 8284363. https://doi.org/10.1155/2017/8284363
White PF, Song D (1999) New criteria for fast-tracking after outpatient anesthesia: a comparison with the modified Aldrete's scoring system. Anesth Analgesia 88(5):1069–1072
Woodhouse A, Mather LE (1998) The effect of duration of dose delivery with patient-controlled analgesia on the incidence of nausea and vomiting after hysterectomy. Br J Clin Pharmacol 45:57–62
Xiancun L, Song T, Chen X et al (2020) Quadratus lumborum block versus transversus abdominis plane block for postoperative analgesia in patients undergoing abdominal surgeries: a systematic review and meta-analysis of randomized controlled trials. BMC Anesthesiol 20(1):1–10
Yousef NK (2018) Quadratus lumborum block versus transversus abdominis plane block in patients undergoing total abdominal hysterectomy: a randomized prospective controlled trial. Anesthesia Essays Res 12(3):742–747

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